

CLAIMS

1. A thin film piezoelectric resonator comprising:
a substrate having a cavity;
5 a first electrode extending over the cavity;
a piezoelectric film placed on the first electrode; and
a second electrode placed on the piezoelectric film, the second
electrode having a part of a periphery which overlaps on the cavity and is
tapered, the second electrode having an inner angle of 30 degrees or smaller
10 defined by a part of the periphery thereof and a bottom thereof.
2. The thin film piezoelectric resonator of claim 1, wherein the part of
the periphery of the second electrode is tapered and has an inner angle of 15
degrees or larger.
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3. The thin film piezoelectric resonator of claim 1, wherein the cavity
goes through the substrate.
4. The thin film piezoelectric resonator of claim 1, wherein the cavity
20 includes an acoustic reflecting layer embedded therein.
5. The thin film piezoelectric resonator of claim 1, further comprising
an insulator which extends over the second electrode including the periphery
thereof and the piezoelectric film where the second electrode is absent, and
25 has a dielectric constant different from a dielectric constant of the second
electrode.

6. The thin film piezoelectric resonator of claim 1, wherein the insulator is made of a silicon oxide film, a silicon nitride film or an aluminum nitride film.

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7. The thin film piezoelectric resonator of claim 2, further comprising an insulator which extends over the second electrode including the periphery thereof and the piezoelectric film where the second electrode is absent, and has a dielectric constant different from a dielectric constant of the second electrode.

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8. The thin film piezoelectric resonator of claim 2, wherein the insulator is made of a silicon oxide film, a silicon nitride film or an aluminum nitride film.

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9. A thin film piezoelectric resonator comprising:

a substrate having a cavity;

a first electrode extending over the cavity;

a piezoelectric film placed on the first electrode;

a second electrode placed on the piezoelectric film and having a part of a periphery thereof which overlaps on the cavity, and

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an insulator placed on the second electrode and the piezoelectric film where the second electrode is absent, and being thin on the center of the second electrode and thick on the periphery of the second electrode.

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10. The thin film piezoelectric resonator of claim 9, wherein the insulator

is thick in a range of 1 μm to 10 μm on the periphery of the second electrode, and is thin on the remaining part of the second electrode.

11. The thin film piezoelectric resonator of claim 9, wherein the insulator
5 is thick in a range of 2 μm to 5 μm on the periphery of the second electrode, and is thin at the remaining part of the second electrode.

12. The thin film piezoelectric resonator of claim 9, wherein the insulator
is made of a silicon oxide film, a silicon nitride film or an aluminum nitride
10 film.

13. The thin film piezoelectric resonator of claim 9, wherein an acoustic reflecting layer is embedded in the cavity.

15 14. A thin film piezoelectric resonator comprising:
a substrate having a cavity;
a first electrode extending over the cavity;
a piezoelectric film placed on the first electrode;
a second electrode placed on the piezoelectric film and having a part
20 of a periphery which overlaps on the cavity, is tapered, and has an inner angle of 30 degrees or smaller defined by a part of the periphery thereof and a bottom thereof; and
an insulator placed on the second electrode and the piezoelectric film where the second electrode is absent, and being thin on the center of the
25 second electrode and thick on the periphery of the second electrode.

15. The thin film piezoelectric resonator of claim 14, wherein the periphery of the second electrode is tapered and has an inner angle of 15 degrees or larger.

5 16. A thin film piezoelectric resonator comprising:
a substrate having a cavity;
a first electrode extending over the cavity;
a piezoelectric film placed on the first electrode;
a second electrode placed on the piezoelectric film and having a
10 periphery which overlaps on the cavity, and
an insulator placed on the second electrode and the piezoelectric film
where the second electrode is absent, and having the thickness varying on
the piezoelectric film and on the periphery of the second electrode.

15 17. A method of manufacturing a thin film piezoelectric resonator, the
method comprising:
making a cavity in a substrate;
making a first electrode over the cavity;
making a piezoelectric film on the first electrode;
20 making an electrode forming layer on the piezoelectric film;
making a photo - resist layer on the electrode forming layer, the
photo - resist layer overlapping on the cavity;
tapering an edge of the photo - resist layer, the tapered photo - resist
layer having an acute angle and serving as a mask; and
25 patterning the electrode layer using the mask in order to make a
second electrode, and transferring a shape of the tapered edge of the mask

onto an end of the second electrode, the tapered edge of the second electrode having an acute inner angle.

18. The method of manufacturing the thin film piezoelectric resonator of claim 17, wherein in the mask making process, the photo - resist layer is baked to taper the edge of the resist layer.

19. The method of manufacturing the thin film piezoelectric resonator of claim 17, wherein the electrode layer is dry - etched using the mask in order to make and taper the periphery of the second electrode.

20. The method of manufacturing the thin film piezoelectric resonator of claim 19, wherein the electrode layer is tapered and has an inner angle of between 15 degrees or larger and 30 degrees or smaller defined by a part of the periphery thereof and a bottom thereof.